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ON THE EXPERIENCE OF TIME.

IN the present article, we shall be concerned with all those immediate experiences upon which our knowledge of time is based. Broadly speaking, two pairs of relations have to be considered, namely, (*a*) sensation and memory, which give time-relations between object and subject, (*b*) simultaneity and succession, which give time-relations among objects. It is of the utmost importance not to confuse time-relations of subject and object with time-relations of object and object; in fact, many of the worst difficulties in the psychology and metaphysics of time have arisen from this confusion. It will be seen that past, present, and future arise from time-relations of subject and object, while earlier and later arise from time-relations of object and object. In a world in which there was no experience there would be no past, present, or future, but there might well be earlier and later. Let us give the name of *mental time* to the time which arises through relations of subject and object, and the name *physical time* to the time which arises through relations of object and object. We have to consider what are the elements in immediate experience which lead to our knowledge of these two sorts of time, or rather of time-relations.

Although, in the finished logical theory of time, physical time is simpler than mental time, yet in the analysis of experience it would seem that mental time must come first. The essence of physical time is succession; but the experience of succession will be very different according

as the objects concerned are both remembered, one remembered and one given in sense, or both given in sense. Thus the analysis of sensation and memory must precede the discussion of physical time.

Before entering upon any detail, it may be well to state in summary form the theory which is to be advocated.

1. *Sensation* (including the apprehension of present mental facts by introspection) is a certain relation of subject and object, involving acquaintance, but recognizably different from any other experienced relation of subject and object.

2. Objects of sensation are said to be *present* to their subject in the experience in which they are objects.

3. Simultaneity is a relation among entities, which is given in experience as sometimes holding between objects present to a given subject in a single experience.

4. An entity is said to be *now* if it is simultaneous with what is present to me, i. e., with *this*, where "this" is the proper name of an object of sensation of which I am aware.

5. *The present time* may be defined as a class of all entities that are *now*. [This definition may require modification; it will be discussed later.]

6. *Immediate Memory* is a certain relation of subject and object, involving acquaintance, but recognizably different from any other experienced relation of subject and object.

7. *Succession* is a relation which may hold between two parts of one sensation, for instance between parts of a swift movement which is the object of one sensation; it may then, and perhaps also when one or both objects are objects of immediate memory, be immediately experienced, and extended by inference to cases where one or both of the terms of the relation are not present.

8: When one event is succeeded by another, the first is called *earlier* and the second *later*.

9. An event which is earlier than the whole of the present is called *past*, and an event which is later than the whole of the present is called *future*.

This ends our definitions, but we still need certain propositions constituting and connecting the mental and physical time-series. The chief of these are:

a. Simultaneity and succession both give rise to transitive relations; simultaneity is symmetrical, while succession is asymmetrical, or at least gives rise to an asymmetrical relation defined in terms of it.

b. What is remembered is past.

c. Whenever a change is immediately experienced in sensation, parts of the present are earlier than other parts. (This follows logically from the definitions.)

d. It may happen that A and B form part of one sensation, and likewise B and C, but when C is an object of sensation A is an object of memory. Thus the relation "belonging to the same present" is not transitive, and two presents may overlap without coinciding.

The above definitions and propositions must now be explained and amplified.

1. *Sensation*, from the point of view of psychophysics, will be concerned only with objects not involving introspection. But from the point of view of theory of knowledge, all acquaintance with the present may advantageously be combined under one head, and therefore, if there is introspective knowledge of the present, we will include this with sensation. It is sometimes said that all introspective knowledge is of the nature of memory; we will not now consider this opinion, but will merely say that *if* introspection ever gives acquaintance with present mental entities in the way in which the senses give acquaintance with present physical entities, then such acquaintance with mental entities is, *for our purposes*, to be included under the head of sensation. Sensation, then, is that kind of

acquaintance with particulars which enables us to know that they are at the present time. The object of a sensation we will call a *sense-datum*. Thus to a given subject sense-data are those of its objects which can be known, from the nature of their relation to the subject, to be at the present time.

The question naturally arises: how do we know whether an object is present or past or without position in time? Mere acquaintance, as we decided in considering imagination, does not necessarily involve any given temporal relation to the subject. How, then, is the temporal relation given? Since there can be no *intrinsic* difference between present and past objects, and yet we can distinguish by inspection between objects given as present and those given as past, it follows from the criterion set forth at the beginning of the preceding chapter that the relation of subject to object must be different, and recognizably different, according as the object is present or past. Thus sensation must be a special relation of subject and object, different from any relation which does not show that the object is at the present time. Having come to this result, it is natural to accept "sensation" as an ultimate, and define the present time in terms of it; for otherwise we should have to use some such phrase as "given as at the present time," which would demand further analysis, and would almost inevitably lead us back to the relation of sensation as what is meant by the phrase "given as at the present time." For this reason, we accept sensation as one of the ultimates by means of which time-relations are to be defined.

2. Our theory of time requires a definition, without presupposing time, of what is meant by "one (momentary) total experience." This question has been already considered in a previous article, where we decided that "being experienced together" is an ultimate relation among objects, which is itself sometimes immediately experienced as

holding between two objects. We cannot analyze this into "being experienced by the same subject," because A and B may be experienced together, and likewise B and C, while A and C are not experienced together: this will happen if A and B form part of one "specious present," and likewise B and C, but A is already past when C is experienced. Thus "being experienced together" is best taken as a simple relation. Although this relation is sometimes perceived, it may of course also hold when it is not perceived. Thus "one (momentary) total experience" will be the experience of all that group of objects which are experienced together with a given object. This, however, still contains a difficulty, when viewed as a definition, namely that it assumes that no object is experienced twice, or throughout a longer time than one specious present. This difficulty must be solved before we can proceed.

Two opposite dangers confront any theory on this point. (a) If we say that no one object can be experienced twice, or rather, to avoid what would be *obviously* false, that no one object can be twice an object of sense, we have to ask what is meant by "twice." If a time intervenes between the two occasions, we can say that the object is not numerically the same on the two occasions; or, if that is thought false, we can say at least that the experience is not numerically the same on the two occasions. We can then define "one (momentary) total experience" as everything experienced together with "this," where "this" is an experience, not merely the object of an experience. By this means, we shall avoid the difficulty in the case when "twice" means "at two times separated by an interval when the experience in question is absent." But when what seems to be the same experience persists through a longer continuous period than one specious present, the overlapping of successive specious presents introduces a new difficulty. Suppose, to fix our ideas, that I look steadily at

a motionless object while I hear a succession of sounds. The sounds A and B, though successive, may be experienced together, and therefore my seeing of the object while I hear these sounds need not be supposed to constitute two different experiences. But the same applies to what I see while I hear the sounds B and C. Thus the experience of seeing the given object will be the same at the time of the sound A and at the time of the sound C, although these two times may well not be parts of one specious present. Thus our definition will show that the hearing of A and the hearing of C form parts of one experience, which is plainly contrary to what we mean by one experience. Suppose, to escape this conclusion, we say that my seeing the object is a different experience while I am hearing A from what it is while I am hearing B. Then we shall be forced to deny that the hearing of A and the hearing of B form parts of one experience. In that case, the perception of change will become inexplicable, and we shall be driven to greater and greater subdivision, owing to the fact that changes are constantly occurring. We shall thus be forced to conclude that one experience cannot last for more than one mathematical instant, which is absurd.

b. Having been thus forced to reject the view that the existence of one experience must be confined within one specious present, we have now to consider how we can define "one (momentary) total experience" on the hypothesis that a numerically identical experience may persist throughout a longer period than one specious present. It is obvious that no one experience will now suffice for definition. All that falls within one (momentary) total experience must belong to one specious present, but what is experienced together with a given experience need not, on our present hypothesis, fall within one specious present. We can, however, avoid all difficulties by defining "one (momentary) total experience" as a group of objects such

that *any two* are experienced together, and nothing outside the group is experienced together with all of them. Thus, for example, if A and B, though not simultaneous, are experienced together, and if B and C likewise are experienced together, C will not belong to one experience with A and B unless A and C also are experienced together. And given any larger group of objects, any two of which are experienced together, there is some one (momentary) total experience to which they all belong; but a new object *x* cannot be pronounced a member of this total experience until it has been found to be experienced together with all the members of the group. A given object will, in general, belong to many different (momentary) total experiences. Suppose, for example, the sounds A, B, C, D, E occur in succession, and three of them can be experienced together. Then C will belong to a total experience containing A, B, C, to one containing B, C, D, and to one containing C, D, E. In this way, in spite of the fact that the specious present lasts for a certain length of time, experience permits us to assign the temporal position of an object much more accurately than merely within one specious present. In the above instance, C is at the end of the specious present of A, B, C, in the middle of that of B, C, D, and at the beginning of that of C, D, E. And by introducing less discrete changes the temporal position of C can be assigned even more accurately.

We may thus make the following definitions:

"One (momentary) total experience," is a group of experiences such that the objects of any two of them are experienced together, and anything experienced together with all members of the group is a member of the group.

The "specious present" of a momentary total experience is the period of time within which an object must lie in order to be a sense-datum in that experience.

This second definition needs some amplification. If an

object has ceased to exist just before a given instant,¹ it may still be an object of sense at that instant. We may suppose that, of all the present objects of sense which have already ceased to exist, there is one which ceased to exist longest ago; at any rate a certain stretch of time is defined from the present instant back through the various moments when present objects of sense ceased to exist. This stretch is the "specious present." It will be observed that this is a complicated notion, involving mathematical time as well as psychological presence. The purely psychological notion which underlies it is the notion of one (momentary) total experience.

Sense-data belonging to one (momentary) total experience are said to be *present* in that experience. This is a merely verbal definition.

The above definitions still involve a certain difficulty, though perhaps not an insuperable one. We have admitted provisionally that a given particular may exist at different times. If it should happen that the whole group of particulars constituting one (momentary) total experience should recur, all our definitions of "the present time" and allied notions would become ambiguous. It is no answer to say that such recurrence is improbable: "the present time" is plainly not ambiguous, and would not be so if such recurrence took place. In order to avoid the difficulty, one of two things is necessary. Either we must show that such complete recurrence is *impossible*, not merely improbable; or we must admit absolute time, i. e., admit that there is an entity called a "moment" (or a "period of time" possibly) which is not a mere relation between events, and is involved in assigning the temporal position of an object. The problem thus raised is serious; but it belongs rather to the physical than to the psychological analysis of time. Within our experience, complete recur-

¹ The word "instant" has a meaning defined later in the present article.

rence does not occur. So long, therefore, as we are considering merely the psychological genesis of our knowledge of time, objections derived from the possibility of recurrence may be temporarily put aside. We shall return to this question at a later stage of this article.

3. *Simultaneity*. This is a relation belonging to "physical" time, i. e., it is a relation between objects primarily, rather than between object and subject. By inference, we may conclude that sense-data are simultaneous with their subjects, i. e., that when an object is present to a subject, it is simultaneous with it. But the relation of simultaneity which is here intended is one which is primarily given in experience only as holding among objects. It does not mean simply "both present together." There are two reasons against such a definition. First, we wish to be able to speak of two entities as simultaneous when they are not both parts of one experience, i. e., when one or both are only known by description; thus we must have a meaning of simultaneity which does not introduce a subject. Secondly, in all cases where there is a change within what is present in one experience, there will be succession, and therefore absence of simultaneity, between two objects which are both present. When two objects form part of one present, they *may* be simultaneous, and their simultaneity *may* be immediately experienced. It is however by no means necessary that they should be simultaneous in this case, nor that, if they are in fact simultaneous, they should form part of what is present in one experience. The only point of connection, so far as knowledge is concerned, between simultaneity and presence, is that simultaneity can only be *experienced* between objects which are both present in one experience.

4. *The definition of "now."* We saw that both "I" and "now" are to be defined in terms of "this," where "this" is the object of attention. In order to define "now," it is

necessary that "this" should be a sense-datum. Then "now" means "simultaneous with this." Since the sense-datum may lie anywhere within the specious present, "now" is to that extent ambiguous; to avoid this ambiguity, we may define "now" as meaning "simultaneous with some part of the specious present." This definition avoids ambiguity, but loses the essential simplicity which makes "now" important. When nothing is said to be contrary, we shall adopt the first definition; thus "now" will mean "simultaneous with this," where "this" is a sense-datum.

5. *The present time* is the time of entities which are present, i. e., of all entities simultaneous with some part of the specious present, i. e., of all entities which are "now" in our second, unambiguous sense. If we adopt a relational theory of time, we may define a time simply as the class of all entities which are commonly said to be at that time, i. e., of all entities simultaneous with a given entity, or with a given set of entities if we do not wish to define a mathematical instant. Thus with a relational theory of time, "the present time" will be simply all entities simultaneous with some part of the specious present. With an absolute theory of time, "the present time" will be the time occupied by the specious present. We shall not at present attempt to decide between the absolute and relative theories of time.

This completes our theory of the knowledge of the present. Although knowledge of *succession* is possible without passing outside the present, because the present is a finite interval of time within which changes can occur, yet knowledge of the *past* is not thus obtainable. For this purpose, we have to consider a new relation to objects, namely *memory*. The analysis of memory is a difficult problem, to which we must now turn our attention.

6. *Immediate memory*. Without, as yet, asserting that there is such a thing as immediate memory, we may define

it as "a two-term relation of subject and object, involving acquaintance, and such as to give rise to the knowledge that the object is in the past." This is not intended as a satisfactory definition, but merely as a means of pointing out what is to be discussed. It is indubitable that we have knowledge of the past, and it would seem, though this is not logically demonstrable, that such knowledge arises from acquaintance with past objects in a way enabling us to know that they are past. The existence, extent, and nature of such immediate knowledge of the past is now to be investigated.

There are two questions to be considered, here as in theory of knowledge generally. First, there is the question: What sort of data would be logically capable of giving rise to the knowledge we possess? And secondly, there is the question: How far does introspection or other observation decide which of the logically possible systems of data is actually realized? We will deal with the first question first.

We certainly know what we mean by saying "such-and-such an event occurred in the past." I do not mean that we know this *analytically*, because that will only be the case with those (if any) who have an adequate philosophy of time; I mean only that we know it in the sense that the phrase expresses a thought recognizably different from other thoughts. Thus we must understand complexes into which "past," or whatever is the essential constituent of "past," enters as a constituent. Again it is obvious that "past" expresses a relation to "present," i. e., a thing is "past" when it has a certain relation to the present, or to a constituent of the present. At first sight, we should naturally say that what is past cannot also be present; but this would be to assume that no particular can exist at two different times, or endure throughout a finite period of time. It would be a mistake to make such an assumption, and therefore we shall not say that what is past cannot also

be present. If there is a sense in which this is true, it will emerge later, but ought not to be part of what is originally taken as obvious.

The question now arises whether "past" can be defined by relation to some one constituent of the present, or whether it involves the whole present experience. This question is bound up with another question, namely, can "past" be defined as "earlier than the present"? We have seen that *succession* may occur within the present; and when A is succeeded by B, we say that A is earlier than B. Thus "earlier" can be understood without passing outside the present. We cannot say, however, that the past is whatever is earlier than this or that constituent of the present, because the present has no sharp boundaries, and no constituent of it can be picked out as certainly the earliest. Thus if we choose any one constituent of the present, there may be earlier entities which are present and not past. If, therefore, "past" is to be defined in terms of "earlier," it must be defined as "earlier than the whole of the present." This definition would not be open to any *logical* objection, but I think it cannot represent the epistemological analysis of our knowledge of the past, since it is quite obvious that, in order to know that a given entity is in the past, it is not necessary to review the whole present and find that it is all later than the given entity. This argument seems to show that the past must be definable without explicit reference to the whole present, and must therefore not be defined in terms of "earlier."

Another question, by no means easy to answer, is this: Does our knowledge of the past involve *acquaintance* with past objects, or can it be accounted for on the supposition that only knowledge by description is involved in our knowledge of the past? That is, must our knowledge of the past be derived from such propositions as "*This* is past," where *this* is an object of present acquaintance, or

can it be wholly derived from propositions of the form: "An entity with such-and-such characteristics existed in the past"? The latter view might be maintained, for example, by introducing images: it might be said that we have images which we know to be more or less like objects of past experience, but that the simplest knowledge we have concerning such objects is their resemblance to images. In this case, the simplest *cognition* upon which our knowledge of the past is built will be perception of the fact "this-resembles-something-in-the-past," where *this* is an image, and "something" is an "apparent variable." I do not believe that such a view is tenable. No doubt, in cases of remembering something not very recent, we have often only acquaintance with an image, combined with the *judgment* that something like the image occurred in the past. But such memory is liable to error, and therefore does not involve *perception* of a fact of which "past" is a constituent. Since, however, the word "past" has significance for us, there must be perception of facts in which it occurs, and in such cases memory must be not liable to error. I conclude that, though other complications are logically possible, there must, in some cases, be immediate acquaintance with past objects given in a way which enables us to know that they are past, though such acquaintance may be confined to the very recent past.

Coming now to what psychology has to say as to the empirical facts, we find three phenomena which it is important to distinguish. There is first what may be called "physiological" memory, which is simply the persistence of a sensation for a short time after the stimulus is removed. The time during which we see a flash of lightning is longer than the time during which the flash of lightning, as a physical object, exists. This fact is irrelevant to us, since it has nothing to do with anything discoverable by introspection alone. Throughout the period of "physio-

logical memory," the sense-datum is actually *present*; it is only the inferred physical object which has ceased.

Secondly, there is our awareness of the *immediate* past, the short period during which the warmth of sensation gradually dies out of receding objects, as if we saw them under a fading light. The sound we heard a few seconds ago, but are not hearing now, may still be an object of acquaintance, but is given in a different way from that in which it was given when it was a sense-datum. James² seems to include what is thus still given in the "specious present," but however we may choose to define the "specious present," it is certain that the object thus given, but not given in sense, is given in the way which makes us call it *past*; and James³ rightly states that it is this experience which is "the *original* of our experience of pastness, from whence we get the meaning of the term."

Thirdly, there is our knowledge concerning more remote portions of the past. Such knowledge is more difficult to analyze, and is no doubt derivative and complicated, as well as liable to error. It does not, therefore, belong to the elementary constituents of our acquaintance with the world, which are what concern us at present. Or, if it does contain some elementary constituent, it must be one which is not essential to our having a knowledge of time, though it may increase the extent of our knowledge concerning past events.

Thus of the three phenomena which we have been considering, only the second seems directly relevant to our present problem. We will give the name "immediate memory" to the relation which we have to an object which has recently been a sense-datum, but is now felt as past, though still given in acquaintance. It is essential that the object of immediate memory should be, at least in part, identical with the object

² Cf., e. g., *Psychology*, Vol. I, p. 630.

³ *Loc. cit.*, p. 604.

previously given in sense, since otherwise immediate memory would not give acquaintance with what is past, and would not serve to account for our knowledge of the past. Hence, by our usual criterion, since immediate memory is intrinsically distinguishable from sensation, it follows that it is a different relation between subject and object. We shall take it as a primitive constituent of experience. We may define one entity as "past" with respect to another when it has to the other that relation which is experienced, in the consciousness of immediate memory, as existing between object and subject. This relation, of course, will come to be known to hold in a vast number of cases in which it is not experienced; the epistemological need of the immediate experience is to make us know what is meant by "past," and to give us data upon which our subsequent knowledge can be built. It will be observed that in order to know a past object we only need immediate memory, but in order to know what is meant by "past," an immediate remembering must be itself made an object of experience. Thus introspection is necessary in order to understand the meaning of "past," because the only cases in which this relation is immediately given are cases in which one term is the subject. Thus "past," like "present," is a notion derived from psychology, whereas "earlier" and "later" can be known by an experience of non-mental objects.

The extent of immediate memory, important as it is for other problems, need not now concern us; nor is it necessary to discuss what is meant by memory of objects with which we are no longer acquainted. The bare materials for the knowledge that there is a time-series can, I think, be provided without considering any form of memory beyond immediate memory.

7. *Succession* is a relation which is given between objects, and belongs to physical time, where it plays a part analogous to that played by memory in the construction of

mental time. Succession may be immediately experienced between parts of one sense-datum, for example in the case of a swift movement; in this case, the two objects of which one is succeeded by the other are both parts of the present. It would seem that succession may also be immediately experienced between an object of immediate memory and a sense-datum, or between two objects of immediate memory. The extensions of our knowledge of succession by inference need not now concern us.

8. We say that A is *earlier* than B if A is succeeded by B; and in the same case we say B is *later* than A. These are purely verbal definitions. It should be observed that *earlier* and *later* are relations given as between objects, and not in any way implying past and present. There is no logical reason why the relations of earlier and later should not subsist in a world wholly devoid of consciousness.

9. An event is said to be *past* when it is earlier than the whole of the present, and is said to be *future* when it is later than the whole of the present. It is necessary to include the *whole* of the present, since an event may be earlier than *part* of the present and yet be itself present, in cases where there is succession within the present. It is also necessary to define the past by means of *earlier* rather than by means of memory, since there may be things in the past which are neither themselves remembered nor simultaneous with anything remembered. It should be noted that there is no experience of the future. I do not mean that no particulars which are future are or have been experienced, because if a particular recurs or endures it may be experienced at the earlier time. What I mean is that there is no experience of anything *as* future, in the way in which sensation experiences a thing as present and memory experiences it as past. Thus the future is only known by inference, and is only known *descriptively*, as "what succeeds the present."

Having now ended our definitions, we must proceed to the propositions constructing and connecting the physical and mental time-series.

a. Simultaneity and succession both give rise to transitive relations, while simultaneity is symmetrical, and succession asymmetrical, or at least gives rise to an asymmetrical relation defined in terms of it.

This proposition is required for the construction of the physical time-series. At first sight, it might seem to raise no difficulties, but as a matter of fact it raises great difficulties, if we admit the possibility of recurrence. These difficulties are so great that they seem to make either the denial of recurrence of particulars or the admission of absolute time almost unavoidable.

Let us begin with simultaneity. Suppose that I see a given object A continuously while I am hearing two successive sounds B and C. Then B is simultaneous with A and A with C, but B is not simultaneous with C. Thus it would seem to follow that simultaneity, in the sense in which we have been using the word, is not transitive. We might escape this conclusion by denying that any numerically identical particular ever exists at two different instants: thus instead of the one A, we shall have a series of A's, not differing as to predicates, one for each instant during which we had thought that A endures. Such a view would not be logically untenable, but it seems incredible, and almost any other tenable theory would seem preferable.

In the same way as we defined one (momentary) total experience, we may, if we wish to avoid absolute time, define an "instant" as a group of events *any two* of which are simultaneous with each other, and not all of which are simultaneous with anything outside the group. Then an event is "at" an instant when it is a member of the class which is that instant. When a number of events are all at the same instant, they are related in the way which

we have in mind when we think that simultaneity is transitive. It must be observed that we do not thus obtain a transitive two-term relation unless the instant is *specified*: "A and B are at the instant *t*" is transitive, but "there is an instant at which A and B are" holds whenever A and B are simultaneous, and is thus not transitive. In spite of this, however, the above definition of an "instant" provides formally what is required, so far as simultaneity is concerned. It is only so far as succession is concerned that this definition will be found inadequate.

Succession, if the time-series is to be constituted, must give rise to an asymmetrical transitive relation. Now if recurrence or persistence is possible, succession itself will have neither of these properties. If A occurs before B, and again after B, we have a case where succession is not asymmetrical. If B occurs both before A and after C, while A occurs before C but never occurs after C, A will succeed B and B will succeed C, but A will not succeed C; thus succession will not be transitive. Let us consider how this is affected if we pass on to "instants" in the sense above defined. We may say that one instant is *posterior* to another, and the other *anterior* to the one, if every member of the one succeeds every member of the other. But now we are faced with the possibility of *repetition*, i. e., of an instant being posterior to itself. If everything in the universe at one instant were to occur again after a certain interval, so as again to constitute an instant, the anterior and posterior instants would be *identical* according to our present definition. This result cannot be avoided by altering the definition of *anterior* and *posterior*. It can only be avoided by finding some set of entities of which we know that they cannot recur. If we took Bergson's view, according to which our mental life at each moment is intrinsically different, owing to memory, from that of a moment preceded by different experiences, then the experience of each mo-

ment of life is unique, and can be used to define an instant. In this way, if the whole universe may be taken as one experience, the time-series can be constructed by means of memory. There is no *logical* error in such a procedure, but there is a greater accumulation of questionable metaphysics than is suitable for our purposes. We must, therefore, seek for some other way of constructing the time-series.

It is no answer to our difficulty to reply that the complete recurrence of the whole momentary state of the universe is *improbable*. The point of our difficulty is this: If the whole state of the universe did recur, it is obvious that there would be *something* not numerically identical in the two occurrences, something, in fact, which leads us to speak of "two occurrences." It would be contrary to what is self-evident to say that there was strictly *one* occurrence, which was anterior and posterior to itself. Without taking account of the whole universe, if a thing A exists at one time, then ceases, and then exists again at a later time, it seems obvious that there is *some* numerical diversity involved, even if A is numerically the same. In this case, in fact, where A reappears after an absence, it would seem strained to say that the *same* particular had reappeared: we should more naturally say that a new precisely similar particular had appeared. This is by no means so obvious in the case of a thing which persists unchanged throughout a continuous period. Before going further, we must consider whether there can be any substantial difference between persistence and recurrence.

The view which I wish to advocate is the following. An entity may persist unchanged throughout a continuous portion of time, without any numerical diversity corresponding to the different instants during which it exists; but if an entity ceases to exist, any entity existing at a subsequent time must be numerically diverse from the

one that has ceased. The object of this hypothesis is to preserve, if possible, a relational theory of time; therefore the first thing to be done is to re-state it in terms which do not even verbally imply absolute time. For this purpose, we may adopt the following definitions. We shall say that a thing *exists at several times* if it is simultaneous with things which are not simultaneous with each other. We shall say that it *exists throughout a continuous time* when, if it is simultaneous with two things which are not simultaneous with each other, it is also simultaneous with any thing which comes after the earlier and before the later of the two things. The assumption that two things which are separated by an interval of time cannot be numerically identical is presupposed in the above definition. This assumption, in relational language, may be stated as follows: *If A precedes B and is not simultaneous with it, while B precedes C and is not simultaneous with it, then A and C are numerically diverse.*⁴ We have to inquire whether a logically tenable theory of the time-series can be constructed on this basis.

The difficulty of possible recurrence of the whole state of the universe, which troubled us before, is now obviated. It is now possible to define an *instant* as a class of entities of which any two are simultaneous with each other and not all are simultaneous with any entity outside the class. It will follow that it is meaningless to suppose the universe to persist unchanged throughout a finite time. This is perhaps an objection; on the other hand, it may be said that, when we suppose that such persistence is possible, we are imagining ourselves as spectators watching the unusual immobility with continually increasing astonishment; and in this case, our own feelings, at least, are in a state of change. Let us, then, suppose that it is logically impossible, as our present theory requires, for the universe

⁴ Another form of the same axiom is: *If A both precedes and succeeds B, then A is simultaneous with B.*

to persist unchanged throughout a finite time. Then if two times are different, something must have changed meanwhile; and if this something has changed back so far as its character goes, yet what has reappeared is, in virtue of our assumption, numerically different from what has disappeared. Thus it is impossible that the world should be composed of numerically the same particulars at two different times.

We may now define an *instant* as a class which is identical with all the terms that are simultaneous with every member of itself. We will say that one event "wholly precedes" another when it precedes it without being simultaneous with it; and we will say that one instant is "anterior" to another when there is at least one member of the one instant which wholly precedes at least one member of the other instant. We shall assume that simultaneity is symmetrical, and that every event is simultaneous with itself, so that nothing can wholly precede itself. We will also assume that "wholly preceding" is transitive. These two assumptions together imply our previous assumption, which was that "wholly preceding" is asymmetrical, i. e., that if A wholly precedes B, then B does not wholly precede A. Finally, we will assume that of any two events which are not simultaneous one must wholly precede the other. Then we can prove that "anterior" is a serial relation, so that the instants of time form a series. The only remaining thing that needs to be proved is that there are instants, and that every event belongs to some instant. For this purpose let us call one event an "early part" of another when everything simultaneous with the one is simultaneous with the other, and nothing wholly preceding the one is simultaneous with the other. Let us define the "beginning" of an event as the class of events simultaneous with all its early parts. Then it will be found that, if we assume that any event wholly after something simultaneous with

a given event is wholly after some early part of the given event, then the beginning of an event is an instant of which the event in question is a member.⁵

It would seem, therefore, that the physical time-series can be constructed by means of the relations considered in the earlier part of this article. Our few remaining propositions, which are chiefly concerned with mental time, offer less difficulty.

b. What is remembered is past. It should be noted that the past was defined as "what is earlier than the whole of the present," so that it cannot be supposed that whatever is passed is remembered, nor does memory enter into the *definition* of the past.

c. When a change is immediately experienced in sensation, parts of the present are earlier than other parts. This follows, because, since the change, by hypothesis, lies within sensation, it follows that the earlier and the later state of things are both present according to the definition.

d. If A, B, and C succeed each other rapidly, A and B may be parts of one sensation, and likewise B and C, while A and C are not parts of one sensation, but A is remembered when C is present in sensation. In such a case, A and B belong to the same present, and likewise B and C, but not A and C; thus the relation "belonging to the same present" is not transitive. This has nothing to do with the question of persistence or recurrence which we considered under (*a*), but is an independent fact concerned with mental time, and due to the fact that the present is not an instant. It follows that, apart from any question of duration in objects, two presents may overlap without coinciding.

BERTRAND RUSSELL.

CAMBRIDGE, ENGLAND.

⁵ In symbols, the above theory, with certain logical simplifications, has been set forth by Dr. Norbert Wiener in his "Contributions to the Theory of Relative Position," *Proc. Camb. Phil. Soc.*, Vol. XVII, Part 5, (1914).